





## Tutorial: Development and Implementation of a Multidisciplinary Preoperative Nutrition Optimization Clinic

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### Abstract

Although much is known about surgical risk, little evidence exists regarding how best to proactively address preoperative risk factors to improve surgical outcomes. Preoperative malnutrition is a widely prevalent and modifiable risk factor in patients undergoing surgery. Malnutrition prior to surgery portends significantly higher postoperative mortality, morbidity, length of stay, readmission rates, and hospital costs. Unfortunately, perioperative malnutrition is poorly screened for and remains largely unrecognized and undertreated—a true “silent epidemic” in surgical care. To better address this silent epidemic of surgical nutrition risk, here we describe the rationalization, development, and implementation of a multidisciplinary, registered dietitian–driven, preoperative nutrition optimization clinic program designed to improve perioperative outcomes and reduce cost. Implementation of this novel Perioperative Enhancement Team (POET) Nutrition Clinic required a collaboration among many disciplines, as well as an identified need for multidimensional scheduling template development, data tracking systems, dashboard development, and integration of electronic health records. A structured malnutrition risk score (Perioperative Nutrition Screen score) was developed and is being validated. A structured malnutrition pathway was developed and is under study. Finally, the POET Nutrition Clinic has established a novel role for a perioperative registered dietitian as the integral point person to deliver perioperative nutrition care. We hope this structured model of perioperative nutrition assessment and optimization will allow for wide implementation and generalizability in other centers worldwide to improve recognition and treatment of perioperative nutrition risk. (*JPEN J Parenter Enteral Nutr.* 2020;44:1185–1196)

### Keywords

health outcomes; malnutrition; nutrition risk; preoperative care; registered dietitian; surgery

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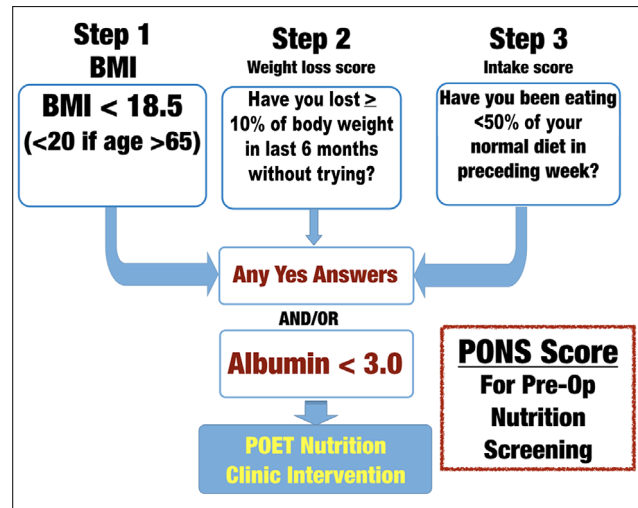
## Introduction

In perioperative medicine, malnutrition is being recognized as a “silent epidemic,” as it is a common and rarely recognized risk factor for poor surgical outcomes. Preoperative malnutrition is associated with significantly higher postoperative mortality, morbidity, length of stay (LOS), readmission rates, and hospital costs<sup>1,2</sup> compared with well-nourished patients. Analysis of US healthcare expenditure between 2009 and 2014 revealed annual costs of disease-associated malnutrition to be >\$15.5 billion. Approximately one-third of that cost was attributed to patients aged 65 years and older.<sup>3</sup> Hospitalized patients with malnutrition incurred costs 30%–50% higher than did well-nourished patients.<sup>4,5</sup> The average per-patient cost of readmission associated with malnutrition has been estimated to be \$16,900–\$17,900 or 26%–34% increased when compared with that of patients without protein-energy malnutrition or postsurgery nonabsorption malnutrition, respectively.<sup>6</sup>

Perioperative malnutrition remains largely underdiagnosed and untreated, despite estimates that 24%–65% of patients undergoing surgery are at significant nutrition risk.<sup>1</sup> Yet only 3.0%–7.1% of hospitalized patients are currently properly identified and diagnosed with malnutrition during their hospitalization.<sup>4</sup> Among colorectal and oncologic surgical patients in the US, only 1 in 5 hospitals currently utilize a formal nutrition screening process.<sup>7</sup> Data from the National Surgical Quality Improvement Program (NSQIP) demonstrate malnutrition to be among the top 10 major preoperative risk factors associated with poor surgical outcomes, including mortality.<sup>8</sup> Furthermore, among the top 10 causes of 30-day surgical mortality in NSQIP data, malnutrition may be the only readily and rapidly modifiable cause.<sup>8</sup> All patients who are to undergo elective surgery at Duke University Hospital are evaluated to determine their readiness for surgery in the Perioperative Anesthesia and Surgery Screening (PASS) Clinic.<sup>9</sup> During this evaluation, patient comorbidities and modifiable risk factors known to portend adverse postoperative outcomes are identified. If a modifiable chronic medical condition is recognized to be poorly controlled or uncontrolled, a referral to a Perioperative Enhancement Team (POET) optimization clinics occurs.<sup>10,11</sup> We here describe the rationalization, development, and implementation of a preoperative nutrition optimization program designed to efficiently screen for preoperative malnutrition and proactively provide nutrition care via evidence-based interventions based on malnutrition risk stratification.

## Rationale for Developing a Preoperative Malnutrition Screening Criteria

In this novel preoperative assessment and management model, surgical patients are initially screened at the time of



**Figure 1.** Perioperative Nutrition Screen (PONS). This algorithmic approach is used to identify perioperative malnutrition risk and guide perioperative nutrition intervention. BMI, body mass index; POET, Duke Perioperative Enhancement Team. Adapted and edited from Reference 1.

surgical declaration by a scheduling coordinator or through a self-reported (“EPIC—My Chart”) survey for low body mass index (BMI), unexpected weight loss, or deficient nutrition intake/appetite. Any positive trigger disqualifies the patient for preoperative phone screening eligibility and redirects the patient to be evaluated for an in-person visit in our PASS Clinic. During the in-person visit in our PASS Clinic,<sup>9</sup> a focused evaluation of all modifiable chronic medical comorbid conditions is done. Included in this evaluation is specific attention to the patient’s nutrition health status.

To efficiently screen for perioperative nutrition risk, an easily applied screening tool is critical to characterize and stratify malnutrition in patients undergoing surgery. Although there are screening tools that exist to assess for malnutrition in patients who are already hospitalized,<sup>12–14</sup> there are no screening tools to specifically identify preoperative malnutrition and guide nutrition intervention throughout the perioperative period. Accordingly, the Perioperative Nutrition Screen (PONS)<sup>1</sup> was developed using previously validated screening criteria (ie, Malnutrition Universal Screening Tool [MUST]) adapted for the preoperative patient. Specifically, PONS identifies nutrition risk on the basis of 4 commonly utilized malnutrition criteria: BMI < 18.5 for patients ≤65 years old or BMI < 20 for patients older than 65 years, unintentional weight loss > 10% in last 6 months, <50% of normal oral diet intake in the last week, or a serum albumin level < 3 g/L (Figure 1). Each question in the PONS tool is assigned 1 point for a “positive” response (maximum PONS score of 4). Any patient with PONS ≥ 1 (ie, any positive response to the

PONS questions) is considered high risk for perioperative malnutrition. Patients with a PONS  $\geq 1$  are then referred for further evaluation and management.

The PONS score was developed to efficiently identify and screen for malnutrition risk in presurgical patients. Our intent was to create a risk identification score that could be utilized by any perioperative clinic staff member (nurse, physician, advanced practice provider [APP], etc) who are, in most cases, not trained in malnutrition-specific physical exam findings. The PONS score was intended to allow a range of staff members to quickly and efficiently identify malnutrition risk that then could be followed up by a registered dietitian (RD) referral with further evaluation or used to trigger simple and inexpensive structured intervention with oral nutritional supplements (ONSs). Data show that we currently perform quite poorly in recognizing surgical patients at nutrition risk, and we believe that preoperative malnutrition is truly an unrecognized silent epidemic in surgical care. Thus, we needed a score that was feasible in any preoperative clinic setting to begin to allow for easy identification of these potentially at-risk patients. As it is the first screening tool of its kind, formal validation studies are pending. We have initially begun to observe congruity between patients who screen positive for malnutrition risk by PONS and formal nutrition assessments performed by the POET Nutrition RD. Furthermore, we are currently performing a validation and comparative study vs traditional American Society for Parenteral and Enteral Nutrition (ASPEN)/American Dietetic Association (ADA) malnutrition criteria.

It should be emphasized that the PONS score is not intended to replace a thorough RD evaluation of malnutrition risk; however, currently, we have found there is extremely limited RD utilization in the preoperative clinic setting. We hope to change this and hope to demonstrate that this initial screen will open the eyes of current preoperative providers to the large number of surgical patients at nutrition risk and encourage greater recognition of malnutrition in the perioperative setting.

## Development of Business Case

To enable a business plan to guide staff and space modeling for a perioperative nutrition optimization clinic, we conducted a review of all patients assessed in the PASS Clinic.

The prevalence of malnutrition was determined based on PONS criteria among surgical patients who were preoperatively evaluated in our PASS Clinic prior to elective surgery. Over a sample period of 4 random days within a 4-week period, 273 patients were screened for malnutrition. Seventy-four out of 273 patients (27%) screened positive for malnutrition. In that sample cohort, it was noted that only 6 patients had serum albumin levels drawn and thus qualified for malnutrition risk based on serum albumin levels

(within 6 months). Of the 74 patients who screened positive for malnutrition, 41 (55%) of those patients agreed to an evaluation by an RD for nutrition intervention. The reasons that patients declined further nutrition health evaluation included a belief that there was an insufficient length of time between nutrition risk assessment and surgical date, inability or inconvenience caused by the need for a return visit to the perioperative nutrition clinic for evaluation by a perioperative RD, and a limited understanding of the impact of nutrition on surgical outcomes.

We then reviewed PASS data over a 12-month period. Retrospective review revealed 14,198 patients were evaluated, of which 11,442 were for surgery. We applied a 27% prevalence of malnutrition assumption and presumed approximately 3000 patients would screen positive for malnutrition. We also then applied a 50% assumption of eligible malnourished patients to be amenable to preoperative nutrition intervention and thus estimated that approximately 1500 patients would utilize preoperative nutrition intervention annually. Based on these analysis and assumptions, a decision was made to hire a dedicated perioperative RD to help facilitate perioperative nutrition interventional strategies.

Also based on these sample data together with evidence from the literature describing the prevalence of malnutrition in selective surgical populations,<sup>15-18</sup> 20% of all surgical patients was presumed as the incremental volume that would be referred to our POET Nutrition Clinic. Reimbursement for nutrition care management codes such as CPT 97802 (including diabetes and transplant) is variable and based on the payer. Medicare covers kidney disease (nondialysis and post kidney transplant within 36 months) and diabetes type 1 and 2. Although protein-energy malnutrition is recognized by the Centers for Medicare & Medicaid Services as a condition that increases the cost of hospital care and thus reimbursement,<sup>19</sup> Medicaid does not typically cover preoperative nutrition optimization services when performed by an RD. Based on these assumptions, we budgeted for breaking even or a slight positive contribution margin for the program, without factoring in the value of the program attributed to cost avoidance and improvement in patient outcome from malnutrition risk reduction. In future analysis, we plan to evaluate the financial impact of improved malnutrition coding in surgical patients due to perioperative POET nutrition clinic and RD evaluation via codes that the provider (physician or APP) documented, such as the E43 severe malnutrition code (based on ASPEN/ADA malnutrition criteria). When malnutrition is added as a major complication code (MCC), especially if it is the only MCC, a significant increase in hospital reimbursement occurs if malnutrition is properly documented (ASPEN/ADA criteria) and if an appropriate treatment nutrition plan is included in chart documentation to address malnutrition. This diagnosis of malnutrition (ie, E43) also increases the expected

mortality risk, allows for more accurate representation of a patient's actual expected mortality risk, and can shift the observed vs expected mortality risk, which is often used as a key quality and performance measure in hospital rankings.

### **Development of an electronic health record-Based Screening Tool**

Implementation of the POET Nutrition Clinic required a collaboration among many disciplines, as well as an identified need for development of a multidimensional scheduling template, data tracking systems, dashboard development, and electronic health record integration.

To facilitate tracking, scheduling, and data capture, a provider dashboard was developed. The dashboard includes aggregate data from multiple sources presented in a summarized format and is built to autopopulate patient clinical data contained within the electronic health record that could be used to screen for patient eligibility to a POET Clinic Program. Specific to the POET Nutrition Clinic, BMI (a clinical measurement typically present in each patient's electronic health record unless new to our healthcare system), if  $<18.5$  for patients  $\leq 65$  years old or if  $<20$  for patients older than 65 years, is automatically flagged on the dashboard. Other PONS criteria are also automatically flagged within the electronic health record when recognized as a positive screen.

The identification of malnourished patients or patients at risk for perioperative malnutrition begins before they arrive in the PASS Clinic for preoperative evaluation, through autopopulation of scores to the PASS Clinic providers concerning potential need for referral to POET Nutrition Clinic. These tools use automated logic created from various programs' referral protocols to pull existing data from the electronic health record and display said data to clinicians as color-coded risk scores. Within these banners, green portends low risk; orange, moderate risk; and red, high risk. These scores are displayed on the multiprovider schedule, allowing staff to proactively search ahead in the schedule for potential (ie, red) nutrition banners and schedule optimization appointments with an RD in tandem with PASS or other upcoming appointments. When a red score is clicked, staff can also see for which criteria the patient qualified, allowing the provider to verify information or search for more clinical information if needed. These same data are also displayed within the PASS Navigator to allow the provider both to have this information at hand while completing their PASS evaluation and to be prompted to enter referrals for optimization in the case that a patient had additional information charted during the PASS visit that was not available before their PASS visit. This ensures no patients are missed, by identifying and referring malnourished patients before and during their visit. This early identification of patients prior to their

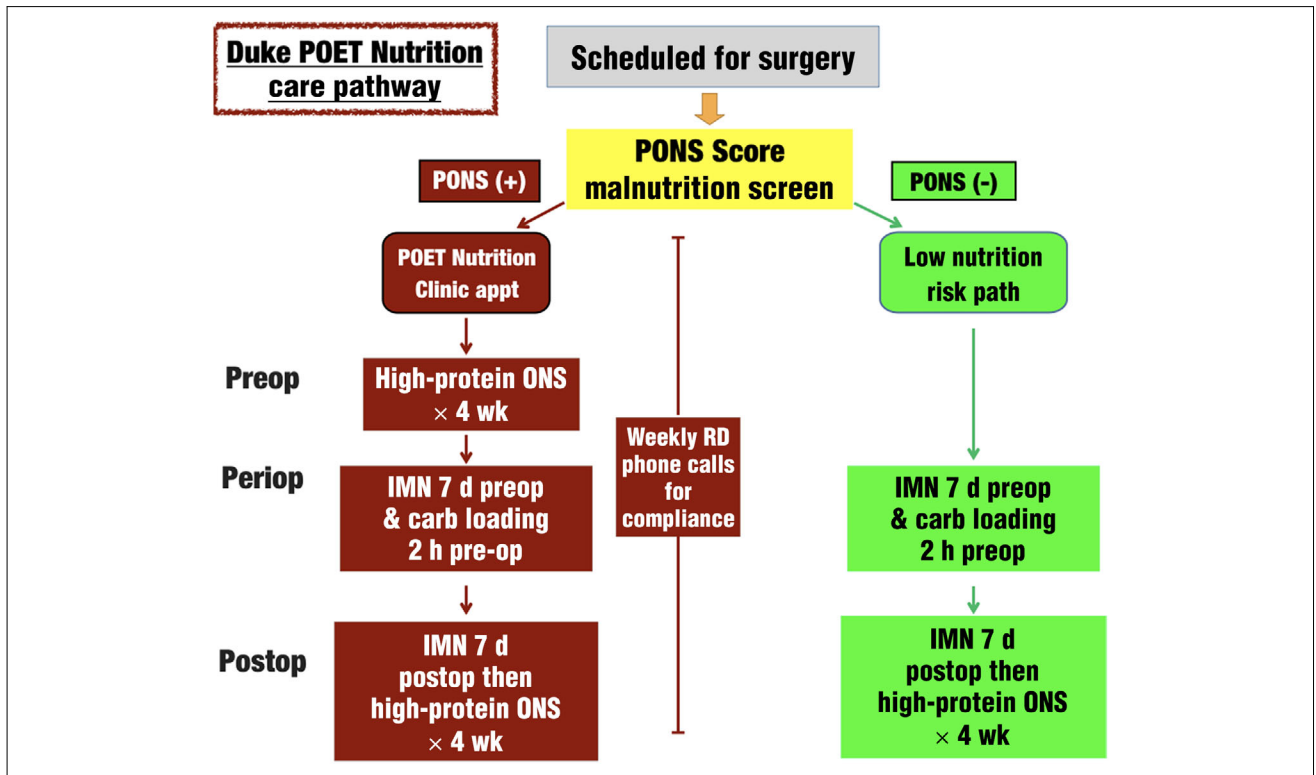
arrival to the PASS Clinic serves as an additional method to ensure capture of high-risk patients in the PASS Clinic. Moreover, data capture and tracking enable scheduling and staffing efficiency. For elements of the PONS that were not autopopulated, we developed a drop-down menu within our electronic health record to enable quick and consistent documentation of perioperative malnutrition risk using the PONS criteria. We also developed electronic ordering sets for efficient ordering of serum albumin and for RD referrals. In addition, an electronic scheduling system was developed to streamline and support the RD appointment requests. We track and monitor our nutrition care pathway from screening to evaluation and on through optimization for ongoing performance improvement.

### **Workflow and Coordination**

Patients are initially evaluated in our PASS Clinic by a care team including an APP under the supervision of a medical director. After an APP identifies a potential need for preoperative optimization, the APP places an electronic referral order to an optimization clinic known as POET clinics. At that time, a nurse navigator is also notified to help facilitate this transition of care and serves as the point person between the nutrition optimization clinic and the APP who initially evaluated the patient in the PASS Clinic. The nurse navigator is responsible for updating the APP on treatment plans and treatment results as well as communicating relevant information back to the referring surgical service.

The nurse navigator also assists with scheduling appointments, orients the patient to the perioperative nutrition optimization process, answers any patient logistic questions, offers additional medical information as needed, and works closely with the PASS Clinic financial care coordinator and social worker to resolve any social issues that may limit the process. Often, this includes insurance verification and ensuring nutrition visits are covered by the patient's insurance. The nurse navigator also helps to arrange transport to and from Duke for patients with limited travel means. Unique to the POET Nutrition Clinic, the nurse navigator helps address patients' needs with assistance for purchasing ONSs. When patients prefer to have their medical care managed by their primary care physicians, the nurse navigator will help coordinate their care to align with the expectations of the POET protocols for perioperative nutrition clinic care.

Once transitioned to the POET Nutrition Clinic, the RD then performs a thorough nutrition evaluation, which includes evaluating quantity and quality of food intake, appetite habits, weight trends, and barriers to healthy nutrition access. The PASS Clinic medical director and POET Nutrition Clinic director works with the RD to determine appropriate laboratory workup and any need for further



**Figure 2.** POET Nutrition Clinic perioperative oral nutrition optimization pathway, based on recent surgical nutrition guideline recommendations.<sup>1</sup> Appt, appointment; carb loading, preoperative carbohydrate-loading drink containing 50 g of 12.5% complex carbohydrate (as maltodextrin); IMN, immunonutrition (ONS with arginine/ $\omega$ -3 fatty acids); ONS, oral nutritional supplement; POET, Duke Perioperative Enhancement Team, PONS, Perioperative Nutrition Screen; RD, registered dietitian.

diagnostic evaluation. When appropriate, an individualized care plan is developed and discussed with the patient.

As part of the perioperative optimization process, patients may be referred to multiple POET clinics and require multiple follow-up visits within a given POET clinic depending on the degree of optimization required.

### Perioperative Nutrition Care Protocols

Recent consensus recommendations from the North American Surgical Nutrition Summit emphasize that nutrition care should be established preoperatively for both malnourished and well-nourished patients to promote optimal nutrition status throughout the perioperative period.<sup>20</sup> These recommendations, in conjunction with critical recent consensus statements from the Perioperative Quality Initiative,<sup>1</sup> have been adopted into a clinical care pathway that highlights the management of perioperative malnutrition. The general presurgical protocol for high-risk patients is to receive high-protein ONSs for 2–4 weeks prior to surgery, immunonutrition supplements for the 7 days prior to surgery, and a complex carbohydrate-loading drink on the morning of surgery (>2 hours

pre-anesthesia). Postoperatively, immunonutrition is given for 7 days and high-protein ONSs for 1 month.

One-third of patients not malnourished at the time of admission become malnourished during their stay at the hospital.<sup>21</sup> It should be noted that the PASS Clinic routinely recommends that all major-surgery patients (regardless of malnutrition risk) take immunonutrition supplements for 7 days prior to surgery, a complex carbohydrate-loading drink on the morning of surgery (>2 hours pre-anesthesia), and postoperative immunonutrition for 7 days as well as high-protein ONSs for 3–4 weeks following surgery, even for patients with no positive PONS findings and thus considered at low risk for perioperative malnutrition (Figure 2).

Essential to each specific nutrition healthcare pathway is a review of the patient's status and compliance with nutrition intervention at weekly intervals by a POET Nutrition Clinic RD. In the nutrition care pathway, patients are reevaluated following a period of clinical intervention and are deemed either nutritionally fit for surgery or not, whereby further optimization is encouraged prior to elective surgery. In this regard, it is important to understand and weigh the risk of delaying surgery in a malnourished patient against the imperative to proceed with surgery. This process

of perioperative optimization of malnutrition requires close collaboration with surgeons.

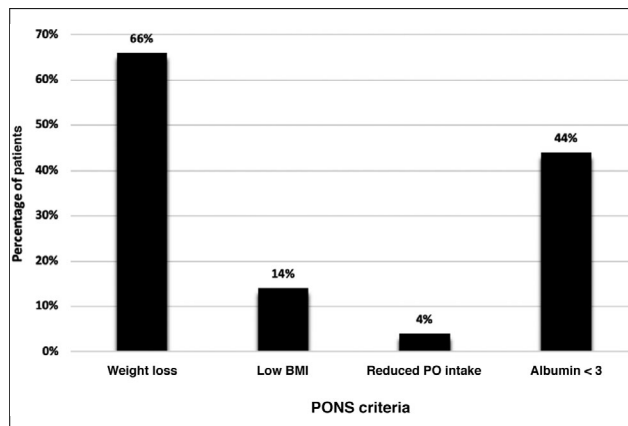
Moreover, it is imperative for patients and their families/caregivers to be involved in decisions surrounding their medical care. We initiate a discussion in the PASS Clinic with patients for whom there is concern and address any questions the patient or their family may have to ensure a positive and clear shared decision-making process. To educate and facilitate active patient engagement in the perioperative nutrition optimization process, patients are provided medical brochures directed to other educational resources with information that defines malnutrition, describes markers used to identify malnutrition, highlights treatment strategies for malnutrition (which includes a formal evaluation by an RD), discusses the risks associated with performing surgery on a malnourished patient, and lists sources for additional information on malnutrition. By both meeting with an RD and improving nutrition health literacy, the POET Nutrition Clinic not only aims to improve nutrition status during the perioperative period but also help patients establish lifelong healthier lifestyle changes that last well beyond the recovery period. The “teachable moment” is thus used to motivate lifestyle modifications and improved nutrition intake for years to come.

In addition to presurgical ambulatory nutrition management and monitoring, the perioperative nutrition model includes an in-hospital nutrition service that rounds and monitors high-risk patients following their surgical procedure. Once a high-risk nutrition patient is admitted to the hospital following surgery, an automatic electronic nutrition consult is generated and placed to our in-patient nutrition service. This consult ensures that the work done preoperatively to optimize the nutrition status of the patient is not lost during the crucial postoperative recovery period and is supported by evidence and guidelines that recommend nutrition support for high-risk and at-risk malnourished patients.<sup>1,22</sup>

Finally, patients are discharged from the hospital with a nutrition plan. Follow-up phone calls from the POET Nutrition Clinic RD occur at 2, 4, and 6 weeks postoperatively, based on the patient’s malnutrition risk, to ensure compliance and optimize functional recovery. At each phone follow-up, nutrition intake is assessed, and nutrition goals are reiterated. Any barriers to maintaining adequate nutrition are identified and addressed and the nutrition plan is amended as necessary. Patients who are unable to meet nutrition requirements once discharged are advised to return to the POET Nutrition Clinic for an in-person reevaluation.

### Preliminary Data on Impact of Program

Since launching the POET Nutrition Clinic in January 2019, 526 patients in our PASS Clinic have been identified as

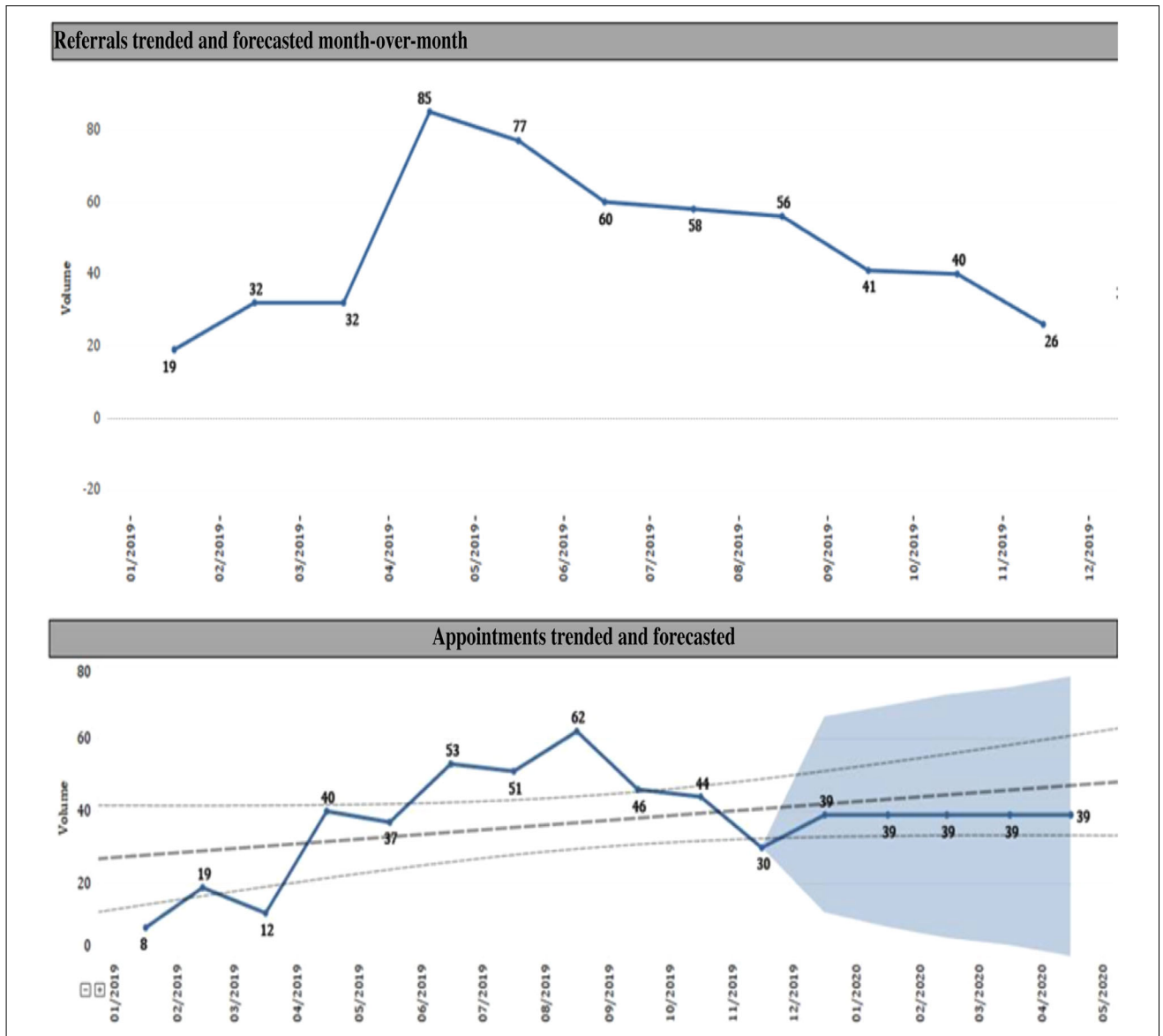


**Figure 3.** POET Nutrition Clinic referral to RD based on PONS score. Indication for RD referral based on PONS score. Any patient who screens positive based on PONS criteria is referred to RD for a thorough nutrition evaluation and initiation of nutrition optimization strategy. PO, Per Os (Oral); POET, Duke Perioperative Enhancement Team, PONS, Perioperative Nutrition Screen; RD, registered dietitian.

being at high risk for malnutrition, using the PONS criteria. Preliminary analysis of the first 239 of these patients reveals that 61 patients declined preoperative nutrition support. Common reasons for declining were, unfortunately, lack of awareness of the importance of nutrition in surgical outcome and concern over spending additional time in clinic for an RD appointment. We are developing patient-specific perioperative nutrition education resources and videos to attempt to address this lack of education on role of nutrition in outcomes. Among the PONS-positive patients, 66% had >10% unplanned weight loss within the past 6 months, 44% had serum albumin levels of <3 g/dL, 14% had a BMI below the age-specific threshold, and 4% had <50% of normal dietary intake (Figure 3).

Once nutrition risk was identified, the average number of days between a patient referral to an RD and an RD evaluation and initiation of therapy was 3 days. Forty-five percent of patients were identified at least 1 week prior to surgery to begin a nutrition intervention. Once a nutrition intervention was initiated, the RD weekly follow-up phone call to patients revealed a compliance rate of 75%. Barriers to compliance include the cost of the ONS, the disfavored taste of the ONS, lack of patient appetite, or gastrointestinal symptoms.

To date, the POET Nutrition Clinic has met its initial conservative break-even budget expectations for the Preoperative Nutrition Health program. This budget included the cost plus benefits for a full-time RD, space, and minimal costs for noncapital equipment (furniture, computer, etc) on the expense ledger. Projected revenue from the Preoperative Nutrition program was based on incremental volumes from a new program. Based on a literature review of preoperative



**Figure 4.** Trends in referrals to POET Nutrition Clinic and scheduled RD preoperative assessment appointments since launch. Projected appointment volume is based on previous year’s trends. POET, Duke Perioperative Enhancement Team, RD, registered dietitian.

malnutrition by surgical procedure and research that showed that nutrition codes for diabetes and transplant are variable and based on the payer, we assumed 10% of surgical patients for our incremental volume analysis. Based on these assumptions, we estimated net professional and technical payments accordingly on the revenue ledger. Since launch, we have not met our forecast for incremental growth. We have since implemented an in-hospital RD consult support system to improve utilization of unfilled capacity while the program grows. That said, we have seen our incremental volume for preoperative ambulatory RD consults increase since launch of the program (Figure 4).

This value-based perioperative nutrition healthcare program was implemented within our institution to help motivate and standardized presurgery nutrition care pathways. Outcomes sets were developed that included tracking malnutrition diagnostic codes for 90-day presurgery against LOS (observed days and index days), observed days in the intensive care unit, 30-day readmissions, and morbidity and mortality. These outcome sets use a data collection tool linked to the electronic health record. To date, we are continuing to track these outcome sets with intent to integrate the information into clinical practice. Based on early signals, we are confident that our

perioperative nutrition healthcare redesign will positively impact patients' postsurgical morbidity and mortality.

### Challenges in Initiating a Preoperative Nutrition Optimization Program

As described above, a key challenge we have faced is patient and provider awareness of the importance of malnutrition in surgical outcome. As described above, in our pilot malnutrition screening of preoperative patients, only 55% of patients with preoperative nutrition risk factors were willing to see an RD prior to surgery. Furthermore, a common reason for patients with identified malnutrition risk declining to set an appointment in the POET Nutrition Clinic with an RD provider is lack of understanding of the importance of perioperative malnutrition in surgical outcome. Thus, a significant number of patients are not having the opportunity to benefit from RD intervention and utilization of simple, effective preoperative nutrition optimization in this setting. To begin to address this, we worked with the independent educational group Abbott Nutrition Health Institute (ANHI) to create patient education posters, which we placed in all preoperative clinic rooms and a range of surgical clinics (Figure 5). These were targeted at both patients and providers. We also created a website with the Duke Clinical Research Institute for perioperative nutrition for patients and providers (<https://dcric.org/our-work/therapeutic-expertise/perioperative-nutrition/>) that contains references and links to videos and podcasts on perioperative nutrition. We further created a series of podcasts for providers and patients that highlighted RDs', physicians', and even patients' experiences and latest evidence for perioperative nutrition care (<https://dcric.org/our-work/therapeutic-expertise/perioperative-nutrition/nutrition-podcast/>). To further address patient awareness of importance of perioperative nutrition screening and therapy, we are planning the creation of brief, specific, "patient-facing" videos for placement on an iPad in surgical and preoperative clinic rooms and waiting rooms. We will also place these online for patient viewing when scheduled for surgery.

A further challenge we identified was seeing patients in a timely manner prior to surgery in our PASS Clinic. To improve early malnutrition risk assessment and opportunity for intervention, we developed a "Direct-to-RD" referral process for the individual surgical subspecialty clinics (ie, Colorectal, Surgical Oncology, Transplant, Vascular, etc). This process allows for clinic providers such as physician assistants, nurse practitioners, nurses, and/or surgeons themselves to refer patients directly to RDs. To facilitate this process, we created a system that allows surgery clinic providers to send scheduled surgical patients notes directly via the electronic health record to our POET Nutrition Clinic RD the day that patients are scheduled for surgery. Within 24–48 hours, the POET preoperative RD calls the patient

directly and screens the patient for malnutrition with PONS score and other nutrition-focused questions. If found to be at nutrition risk, currently we have a Quality Improvement Project at Duke that allows shipment of indicated ONS and other preoperative nutritional supplements (carbohydrate-loading preoperative drinks) directly to patients' homes with overnight delivery free of charge to the patient. Specific instructions for patient referral were included in posters placed in all key surgical clinics (Figure 5). This has led to many successful early referrals and rapid identification and treatment of preoperative nutrition risk.

### Discussion

Perioperative malnutrition is currently largely unrecognized and untreated—creating a true silent epidemic in surgical outcomes that we must address with improved perioperative optimization programs. As malnutrition is known to increase risk of perioperative mortality 5-fold and complications 3-fold in major elective surgery,<sup>1</sup> it is urgent that proactive preoperative nutrition assessment and therapy become a new standard of care.

Several studies have reported that patients who remained well-nourished during hospitalization had lower healthcare costs when compared with those who became malnourished during hospitalization.<sup>21,23</sup> Moreover, several recent studies have shown the cost-effectiveness of providing nutrition supplementation to patients at nutrition risk.<sup>24,25</sup> Postoperative nutrition support is important for maintenance of nutrition status during the catabolic postoperative period and has shown improvement in surgical outcomes,<sup>26,27</sup> but the optimal time period required for preoperative nutrition optimization remains unclear. It has been reported that 7–10 days of preoperative nutrition delivery can markedly improve outcomes.<sup>1</sup> The first challenge to addressing perioperative malnutrition is identifying patients at risk early in the preoperative care pathway via efficient screening tools. We posit the POET Nutrition Clinic model described herein will provide a platform for this and other critical clinical questions to be studied and provide robust data for optimally assessing the effect of nutrition intervention on surgical outcomes. We anticipate that this straightforward model of perioperative nutrition assessment and optimization will allow for wide implementation and generalizability in other centers worldwide. This is particularly timely as many centers worldwide are now adopting Enhanced Recovery After Surgery (ERAS) programs. Furthermore, we hope the model and many resources (ie, posters, podcasts, videos, and other resources) we have developed to promote awareness of importance of perioperative nutrition screening and intervention will provide a framework for other centers to adopt this model in their practice. We know a number of other major academic centers have adopted this model and our treatment pathways, including key perioperative leaders and



# HAVING SURGERY? GOOD NUTRITION MAKES A DIFFERENCE

**WHAT CAN GOOD NUTRITION DO FOR YOU?**

Good nutrition before and after surgery can help you heal faster, fight infection and get home sooner

Below are some topics you might want to discuss with your doctor

**QUESTIONS TO ASK YOUR DOCTOR BEFORE SURGERY**

- Should I consult with a dietitian?
- Will my current weight impact the outcome of my surgery?
- How can nutrition help me prepare for and heal from my surgery?
- What role should exercise play as I prepare for and recover from surgery?

**TELL YOUR DOCTOR IF**

- You've recently lost or gained weight
- You've lost your appetite or are having trouble eating

**ONLY 1 IN 5** malnourished patients receives nutrition supplementation before surgery<sup>3</sup>

Good nutrition can help prevent some of these common complications:

**3 DAYS OF BED REST** following surgery can result in **10% LOSS OF LEG MUSCLE** in older adults<sup>1</sup>

**BEING MALNOURISHED** before surgery results in **3X HIGHER RISK** of complications<sup>2</sup>

**NUTRITION INTERVENTION CAN**

- Reduce infection by 40%<sup>3</sup>
- Decrease length of hospital stay by 2 days<sup>3</sup>

**1 OUT OF 3** patients is at high risk for being malnourished<sup>2</sup>

**2 OUT OF 3** patients having gut surgery are malnourished<sup>2</sup>

Paddon-Jones D. Presented at the 100th Abbott Nutrition Research Conference, June 20-09, Columbus, OH.  
Wischmeyer PE. Nutrition and Surgery: What Every Patient Undergoing Surgery Needs to Know about Nutrition [summary]. Durham: Duke Anesthesiology, 2018.  
The Importance of Perioperative Nutrition [pre-release video]. Abbott Nutrition Health Institute. Forthcoming publication on ANHI.org; 2019.

**NO PATIENT SHOULD UNDERGO SURGERY WITHOUT NUTRITION SCREENING  
BE SURE TO ASK TO SPEAK WITH THE DUKE POET PRE-OPERATIVE  
NUTRITION CLINIC RD PRIOR TO SURGERY**

**Figure 5.** Surgical nutrition awareness poster for preoperative and surgical clinics and programs. The poster also contains key registered dietitian referral instructions for early patient referral. Credit: Paul Wischmeyer (Duke University) and Amie Heap (ANHI).

partners at Vanderbilt University (Matthew McEvoy, MD, in-person discussion, August 15, 2019). We look forward to making any and all resources we create freely available to any center wishing to initiate a preoperative nutrition program. We further hope this RD-driven preoperative nutrition optimization model will become a new and exciting opportunity for RDs around the world to enter a new area in which they are uniquely trained to lead the charge against the “silent epidemic” of preoperative malnutrition.

In conclusion, we describe a model and preliminary experience to efficiently screen patients for preoperative nutrition risk and proactively manage malnutrition before and after surgery. The model will enable perioperative providers to identify and address malnutrition early in a patient’s surgical candidacy. We believe multidisciplinary preoperative nutrition programs will improve nutrition screening, nutrition care, and outcomes for the over 50 million patients having surgery in the US (and around the world). Furthermore, we hypothesize that major cost savings will be realized when preoperative nutrition screening and care are made an essential part of training surgical patients for the “marathon of their lives.”

## Glossary

**APP**—Advanced practice provider, such as a physician assistant or nurse practitioner. These individuals play key roles as front-line providers in preoperative surgical clinics. They are often the primary referral source for patients to the POET Nutrition Clinic and preoperative RD.

**Carb loading**—Preoperative carbohydrate-loading drink containing 50 g of 12.5% complex carbohydrate (as maltodextrin) shown to reduce LOS, nausea, vomiting, and pain and improve other postoperative outcomes in ERAS surgical programs.<sup>1</sup>

**CPT**—Current Procedural Terminology, which is a medical code set maintained by the American Medical Association through the CPT Editorial Panel. The CPT code set describes medical, surgical, and diagnostic services and is designed to communicate uniform information about medical services and procedures among physicians, coders, patients, accreditation organizations, and payers for administrative, financial, and analytical purposes.

**EMR**—Electronic Health record: Essential tool for efficient and timely referrals to POET Nutrition Clinic and preoperative RD.

**EPIC**—Commonly utilized medical health record system. EPIC is the healthcare record used at Duke.

**ERAS**—Enhanced Recovery After Surgery programs: A multifaceted program of interventions in preoperative, interoperative, and postoperative periods to improve surgical outcomes and reduce LOS. Nutrition is essential in all phases of ERAS but is often underappreciated and underutilized.

**IMN**—Immunonutrition (ONS with arginine/ $\omega$ -3 fatty acids) shown to reduce postoperative infectious complication and LOS in a number of large meta-analyses of current trials.<sup>28,29</sup>

**NSQIP**—National Surgical Quality Improvement Program: A large database of >2 million surgical encounters in the US managed by the American College of Surgeons for quality improvement, risk prediction, and health outcomes work.

**ONS**—Oral nutritional supplement: Essential component of oral preoperative, perioperative, and postoperative nutrition pathway (see Figure 2).

**PASS Clinic**—Duke Perioperative Anesthesia and Surgery Screening Clinic.

**POET Clinic**—Duke Perioperative Enhancement Team Clinic: Range of preoperative optimization programs targeted to identify and treat preoperative patients with comorbidities and modifiable risk factors known to portend adverse postoperative outcomes. If a modifiable chronic medical condition is recognized to be poorly controlled or uncontrolled, patients are referred from the PASS Clinic to needed individual clinics (examples of POET Clinics at Duke include Anemia, Diabetes, Nutrition, Pain, Smoking Cessation, etc)

**POET Nutrition Clinic**—Duke Perioperative Enhancement Team Nutrition Clinic: Multidisciplinary team of RDs, APPs, physicians, nurses, and other care providers led by an RD (E. Villalta and MD director [P. E. Wischmeyer]) to optimize perioperative nutrition screening and care.

**PONS score**—Perioperative Nutrition Screen score: Developed using previously validated screening criteria (ie, MUST) adapted for the preoperative patient. Specifically, PONS identifies nutrition risk on the basis of 5 commonly utilized malnutrition criteria: BMI < 18.5 for patients  $\leq 65$  years old or BMI < 20 for patients older than 65 years, plus unintentional weight loss > 10% in last 6 months, <50% of normal oral diet intake in the last week, or a serum albumin level < 3 g/L.

**RD**—Registered dietitian: Integral point person to deliver perioperative nutrition care in emerging perioperative nutrition programs, uniquely trained to lead the charge against the “silent epidemic” of preoperative malnutrition.

## Further Reading

We created a series of podcasts, the Nutrition in Surgery podcast (<https://anhi.org/resources/podcasts-and-videos/dcri-nutrition-in-surgery-series>), for providers and patients that highlights registered dietitians’, physicians’, and patients’ experience with perioperative nutrition. The podcasts provide descriptions of the latest evidence for perioperative nutrition care from range of experts in field.

“American Society for Enhanced Recovery (ASER) and Perioperative Quality Initiative (POQI) joint consensus

statement on nutrition screening and therapy within an enhanced recovery pathway.”<sup>1</sup> Most recent clinical guidelines for surgical nutrition care, including recommendations for nutrition care in ERAS protocols.

“ESPEN guideline: Clinical nutrition in surgery.”<sup>22</sup> ESPEN clinical guidelines for surgical nutrition care.

“Promoting perioperative metabolic and nutritional care.”<sup>30</sup> Comprehensive review article on physiology and clinical evidence around perioperative nutrition.

“The malnourished surgery patient: a silent epidemic in perioperative outcomes?”<sup>31</sup> Review article on demographics and treatment strategies for surgical malnutrition.

“Assessment of perioperative nutrition practices and attitudes—A national survey of colorectal and GI surgical oncology programs.”<sup>32</sup> Survey of colo-rectal and surgical oncology fellowship directors on their views and beliefs on role of nutrition on surgical outcomes.

“Pre-operative nutrition and the elective surgical patient: Why, how and what?”<sup>33</sup> Review article on surgical nutrition.

“Perioperative use of arginine-supplemented diets: A systematic review of the evidence.”<sup>28</sup> Meta-Analysis of immunonutrition ONS on surgical outcomes showing reduced infectious complications and reduced length of stay in a range of major surgical patients.

“Summary points and consensus recommendations from the North American Surgical Nutrition Summit.”<sup>20</sup> Recommendations from a consensus review panel of experts on surgical nutrition.

“A Perioperative medicine model for population health: An integrated approach for an evolving clinical science.”<sup>9</sup> Paper on model of novel perioperative clinic program targeted at optimizing outcomes currently in use at Duke University.

## References

1. Wischmeyer PE, Carli F, Evans DC, et al. American Society for Enhanced Recovery and Perioperative Quality Initiative Joint Consensus Statement on nutrition screening and therapy within a surgical enhanced recovery pathway. *Anesth Analg.* 2018;126(6):1883-1895.
2. Barker LA, Gout BS, Crowe TC. Hospital malnutrition: prevalence, identification and impact on patients and the healthcare system. *Int J Environ Res Public Health.* 2011;8(2):514-527.
3. Goates S, Du K, Braunschweig CA, Arensberg MB. Economic burden of disease-associated malnutrition at the state level. *Plos One.* 2016;11(9):e0161833.
4. Weiss AJ, Fingar KR, Barrett ML, et al. *Characteristics of Hospital Stays Involving Malnutrition, 2013.* HCUP Statistical Brief #210. Rockville, MD: Agency for Healthcare Research and Quality; 2016.
5. Curtis LJ, Bernier P, Jeejeebhoy K, et al. Costs of hospital malnutrition. *Clin Nutr.* 2017;36(5):1391-1396.
6. Fingar KR, Weiss AJ, Barrett ML, et al. *All-Cause Readmissions Following Hospital Stays for Patients With Malnutrition, 2013.* HCUP Statistical Brief #218. Rockville, MD: Agency for Healthcare Research and Quality; 2016.
7. Williams JD, Wischmeyer PE. Assessment of perioperative nutrition practices and attitudes—A national survey of colorectal and GI surgical oncology programs. *Am J Surg.* 2017;213(6):1010-1018.
8. Vaid S, Bell T, Grim R, Ahuja V. Predicting risk of death in general surgery patients on the basis of preoperative variables using American College of Surgeons National Surgical Quality Improvement Program Data. *Perm J.* 2012;16(4):10-17.
9. Aronson S, Westover J, Guinn N, et al. A perioperative medicine model for population health: an integrated approach for an evolving clinical science. *Anesth Analg.* 2018;126(2):682-690.
10. Guinn NR, Guercio JR, Hopkins TJ, et al. How do we develop and implement a preoperative anemia clinic designed to improve perioperative outcomes and reduce cost? *Transfusion.* 2016;56(2):297-303.
11. Setji T, Hopkins TJ, Jimenez M, et al. Rationalization, development, and implementation of a preoperative diabetes optimization program designed to improve perioperative outcomes and reduce cost. *Diabetes Spectr.* 2017;30(3):217-223.
12. Elia M. The MUST report: nutritional screening for adults: a multi-disciplinary responsibility. Berks, UK: BAPEN; 2003.
13. Rugeles SJ, Rueda JD, Diaz CE, Rosselli D. Hyperproteic hypocaloric enteral nutrition in the critically ill patient: a randomized controlled clinical trial. *Indian J Crit Care Med.* 2013;17(6):343-349.
14. Kondrup J, Rasmussen HH, Hamborg O, Stanga Z. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr.* 2003;22(3):321-336.
15. Tobert CM, Mott SL, Nepple KG. Malnutrition diagnosis during adult inpatient hospitalizations: analysis of a multi-institutional collaborative database of academic medical centers. *J Acad Nutr Diet.* 2018;118(1):125-131.
16. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. *BMJ.* 1994;308(6934):945-948.
17. Barrett ML, Bailey MK, Owens PL. Non-maternal and Non-neonatal Inpatient Stays in the United States Involving Malnutrition, 2016. Online. August 30, 2018. U.S. Agency for Healthcare Research and Quality. Available: [www.hcupus.ahrq.gov/reports.jsp](http://www.hcupus.ahrq.gov/reports.jsp).
18. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. *Clin Nutr.* 2008;27(1):5-15.
19. Doley J, Phillips W. Coding for malnutrition in the hospital: does it change reimbursement? *Nutr Clin Pract.* 2019;34(6):823-831.
20. McClave SA, Kozar R, Martindale RG, et al. Summary points and consensus recommendations from the North American Surgical Nutrition Summit. *JPEN J Parenter Enteral Nutr.* 2013;37(5 suppl): 99s-105s.
21. Braunschweig C, Gomez S, Sheean PM. Impact of declines in nutritional status on outcomes in adult patients hospitalized for more than 7 days. *J Am Diet Assoc.* 2000;100(11):1316-1322.
22. Weimann A, Braga M, Carli F, et al. ESPEN guideline: clinical nutrition in surgery. *Clin Nutr.* 2017;36(3):623-650.
23. Russell CA. The impact of malnutrition on healthcare costs and economic considerations for the use of oral nutritional supplements. *Clin Nutr Suppl.* 2007;2(1):25-32.
24. Elia M, Norman C, Norman K, Laviano A. A systematic review of the cost and cost effectiveness of using standard oral nutritional supplements in the hospital setting. *Clin Nutr.* 2016;35(2):370-380.
25. Walzer S, Droschel D, Nuijten M, Chevrou-Séverac H. Health economics evidence for medical nutrition: are these interventions value for money in integrated care? *Clinicoecon Outcomes Res.* 2014;6:241-252.
26. Osland E, Yunus RM, Khan S, Memon MA. Early versus traditional postoperative feeding in patients undergoing resectional gastrointestinal surgery. *JPEN J Parenter Enteral Nutr.* 2011;35(4):473-487.
27. Lewis SJ, Andersen HK, Thomas S. Early enteral nutrition within 24 h of intestinal surgery versus later commencement of feeding: a systematic review and meta-analysis. *J Gastrointest Surg.* 2009;13(3):569-575.

28. Drover JW, Dhaliwal R, Weitzel L, Wischmeyer PE, Ochoa JB, Heyland DK. Perioperative use of arginine-supplemented diets: a systematic review of the evidence. *J Am Coll Surg*. 2011;212(3):385-399.
29. Marimuthu K, Varadhan KK, Ljungqvist O, Lobo DN. A meta-analysis of the effect of combinations of immune modulating nutrients on outcome in patients undergoing major open gastrointestinal surgery. *Ann Surg*. 2012;255(6):1060-1068.
30. Gillis C, Carli F. Promoting perioperative metabolic and nutritional care. *Anesthesiology*. 2015;123(6):1455-1472.
31. Williams DGA, Molinger J, Wischmeyer PE. The malnourished surgery patient? *Curr Opin Anaesthesiol*. 2019;32(3):405-411.
32. Williams JD, Wischmeyer PE. Assessment of perioperative nutrition practices and attitudes—A national survey of colorectal and GI surgical oncology programs. *Am J Surg*. 2017;213(6):1010-1018.
33. Gillis C, Wischmeyer PE. Pre-operative nutrition and the elective surgical patient: why, how and what? *Anaesthesia*. 2019;74(suppl 1):27-35.